MIRO
FM Thermal Vacuum Procedure

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DOCUMENT CHANGE LOG

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1	25-Apr-2001	All	Initial Issue	
2	11-Dec-2006	Section 1.10	Changed reference from PL-0025 to PR-0052	

CONTENTS

Acronyms

C	Centigrade
Deg	degrees
EID-B	Experiment Interface Document, Part B
EQM	Electrical Qualification Model
LFT	Limited Functional Test
MIRO	Microwave Instrument for the Rosetta Orbiter
TRP	Temperature Reference Point

1 MIRO Thermal/Vacuum Test

1.1 Introduction

The following procedure is to be used for MIRO Flight Model Thermal Vacuum Test. This procedure is predicated on the following documents:

RO-MIR-PL-0026	MIRO FM Thermal Vacuum Test Plan
RO-MIR-PR-0049	MIRO Limited Functional Test Procedure
RO-MIR-PR-0053	MIRO FM Calibration Mirror Alignment Verification Procedure
RO-MIR-RS-0005	MIRO Flight Software Requirements Document
144-TV-7/100616	Section 351 ETL Detailed Test Procedure for T/V Chamber 144-TV-7

Details of how to send commands and interpret telemetry are not covered in this procedure. Persons executing this procedure should refer to the above documents if information in these areas is needed.

1.2 General Procedures

1. During the Thermal Vacuum Test, record the four interface temperatures listed below and the voltage and current from the SIS front panel in the log book . Record approximately every 30 minutes.

- Optical Bench Temperature
- SBEU Electronics Interface Temperature
- EU Electronics Interface Temperature
- USO Interface Temperature

2. Transitions between temperatures are performed by controlling the temperatures of the heat exchangers. These exchangers under ETL control. General procedures for thermal transitions are contained in ETL Procedures.

1.3 Ambient Tests

- Perform MIRO Limited Functional Test in air
- Close chamber door
- Check all electrical and RF connections

- Pumpdown (goal is ≥ 7.5 x 10^{-6} Torr) per ETL Procedure
- Perform MIRO Limited Functional Test in vacuum

1.4 Maximum Non-Operating Test

1. Transition to Maximum Non-Operating Temperature of +60° C at 20° C/hour.

   IMPORTANT NOTE: DO NOT EXCEED +63 ° C on any Interface Temperature

   NOTE: In Unit History Log, note the start of the transition period by writing "Begin transition to maximum non-operating temperature".

2. As the temperatures approach +60 ° C, slow heating rate to avoid temperature overshoot and initiate stabilisation phase.
3. When temperatures are stable to ≤ 5° C/hour (can use 0.5 hour period to calculate):
4. Record date and start time of soak period. _____
5. Soak at maximum non-operating temperature for 4 hours
6. Record data and stop time of soak period. _____

1.5 Maximum Operating Test

1. Transition to Maximum Operating Temperatures of +55° C for the SBEU, EU and USO and +40° C for the Optical Bench at 20° C/hour.

   NOTE: In Unit History Log, note the start of the transition period by writing "Begin transition to maximum operating temperature".

2. As the temperatures approach operating conditions, slow cooling rate to avoid temperature overshoot and initiate stabilisation phase.
3. When temperatures are stable to ≤ 5 ° C/hour (can use 0.5 hour period to calculate):
4. Perform MIRO Limited Functional Test
5. Perform MIRO FM Calibration Mirror Alignment Verification Procedure (RO-MIR-PR-0053)
6. Perform MIRO Operational Tests given in Section 2 of this document

1.6 Room Temperature Operating Test

1. Transition to the Room Operating Temperature of +22° C at 20° C/hour on all units.

   NOTE: In Unit History Log, note the start of the transition period by writing "Begin transition to maximum operating temperature".

2. As the temperatures approach operating conditions, slow cooling rate to avoid temperature overshoot and initiate stabilisation phase.

3. When temperatures are stable to ≤ 5 ° C/hour (can use 0.5 hour period to calculate):

4. Perform MIRO Limited Functional Test

5. Perform MIRO FM Calibration Mirror Alignment Verification Procedure (RO-MIR-PR-0053)

6. Perform MIRO Operational Tests given in Section 2 of this document

1.7 Minimum Non-Operating Test

1. Transition to Minimum Non-Operating Temperature of -30 ° C at 20 ° C/hour.

   IMPORTANT NOTE: DO NOT GO BELOW -33° C on any Interface Temperature

   NOTE: In Unit History Log, note the start of the transition period by writing "Begin transition to minimum non-operating temperature".

2. As the temperatures approach -30° C, slow cooling rate to avoid temperature overshoot and initiate stabilisation phase.

3. When temperatures are stable to ≤ 5 ° C/hour (can use 0.5 hour period to calculate):

4. Record date and start time of soak period. _____

5. Soak at minimum non-operating temperature for 4 hours

6. Record data and stop time of soak period. _____

1.8 Minimum Operating Test

1. Transition to Minimum Non-Operating Temperature of -20° C at 20 ° C/hour on all units.

NOTE: In Unit History Log, note the start of the transition period by writing "Begin transition to minimum operating temperature".

2. As the temperatures approach -20^{o} C, slow heating rate to avoid temperature overshoot and initiate stabilisation phase.

3. When temperatures are stable to ≤ 5 ^{o} C/hour (can use 0.5 hour period to calculate):

4. Perform MIRO Limited Functional Test

5. Perform MIRO FM Calibration Mirror Alignment Verification Procedure (RO-MIR-PR-0053)

6. Perform MIRO Operational Tests given in Section 2 of this document

1.9 Cycling Tests

This section of the thermal vacuum test fulfills the ESA cycling requirement of 4 thermal cycles for the instrument. It is an operating soak test.

Cycle 1 was completed in sections 1.3 through 1.8 above. This portion will complete cycles 2 – 4.

1. Change mode to CTS/Dual Continuum if not already in that mode.

2. During Cycle 2 only and while performing step 3 below, perform MIRO SMM Gunn Voltage Auto-control Test given in Section 3 of this document.

3. Transition to Maximum Operating Temperature of +55^{o} C for the SBEU, EU and USO and +40^{o} C for the Optical Bench at 20^{o} C/hour:

   NOTE: In Unit History Log, note the start of each cycle and record the cycle number.

   NOTE: In Unit History Log, note the start of each transition period by writing "Begin transition to maximum operating temperature".

   NOTE: Remember to record the interface temperatures, voltage and current every 30 minutes.

4. As the temperatures approach the maximum operating temperature, slow heating rate to avoid temperature overshoot and initiate stabilisation phase.

5. When temperatures are stable to ≤ 5^{o} C/hour (can use 0.5 hour period to calculate):

6. Record date and start time of soak period. _____

7. Soak at maximum operating temperature for 2 hours

8. Record data and stop time of soak period. _____

9. During Cycle 2 only and while performing step 10 below, perform MIRO Asteroid Mode Test given in Section 3 of this document.

10. Transition to Minimum Operating Temperature of -20 ^{o} C at 20^{o} C/hour:

    NOTE: In Unit History Log, note the start of each cycle and record the cycle number.

    NOTE: In Unit History Log, note the start of each transition period by writing “Begin transition to minimum operating temperature”.

    NOTE: The time estimate for reaching -20 ^{o} C is approximately 4.5 hours.

11. As the temperatures approach minimum operating temperature, slow cooling rate to avoid temperature overshoot and initiate stabilisation phase.

12. When temperatures are stable to ≤ 5^{o} C/hour (can use 0.5 hour period to calculate):

13. Record date and start time of soak period. _____

14. Soak at maximum operating temperature for 2 hours

15. Record data and stop time of soak period. _____

16. Repeat steps 2 – 13 for Cycle 3

17. Record date and start time of soak period. _____

18. Record data and stop time of soak period. _____

19. Repeat steps 2 – 13 for Cycle 4

20. Record date and start time of soak period. _____

21. Record data and stop time of soak period. _____

22. Change mode to Engineering in preparation for calibration

1.10 Calibration

See RO-MIR-PR-0052 for detailed calibration procedures.

1.11 Vacuum Break During Calibration

A vacuum break during the thermal/vacuum test will take place as indicated in Figure 1. After completion of the +25 ^{o} C calibration tests, the following steps shall be performed:

1. Turn off thermal plate heaters.
2. Perform Limited Functional Test in vacuum
3. Backfill chamber
4. Open chamber door
5. Perform Limited Functional Test in air
6. Change out the following RF cables:

   Remove

   - W13: SU.OB.J5 to SBEU.IFP.J11 smmRFE to IFP
   - W7 : SBEU.IFP.J4 to EU.CTS.J7 IFP to CTS

   Install

   - SU.OB.J5 smmRFE IF output
   - SBEU.IFP.J11 IFP smmRFE input
   - SBEU.IFP.J4 IFP spec output
   - EU.CTS.J7 CTS input
   - SBEU.PLE.J181 PLL test port
7. Change out the following RF cables:
8. Perform Limited Functional Test in air
9. Close chamber door
10. Check all electrical and RF connections
11. Pumpdown (goal is ≥ 7.5 x 10 $^{-6}$ Torr) per ETL Procedure
12. Perform Limited Functional Test in vacuum

13. Transition to hot operating temperature (+55 ^{o} C / +40 ^{o} C)
14. Continue calibration procedure

1.12 Transition and Tests for End of Thermal Vacuum Test

1. Transition to +35 ^{o} C @ +20 ^{o} C/hour
2. Turn off thermal plate heaters
3. Allow instrument to cool to ambient (approximately +25 ^{o} C)
4. At ambient temperature, perform Limited Functional Test in vacuum
5. Backfill chamber
6. Perform Limited Functional Test in air

END OF THERMAL VACUUM TEST

2 MIRO Operational Tests

2.1 Setup for tests

1. If MIRO is on, return the instrument to an OFF condition by changing mode to Engineering and powering off.

2. Wait 30 minutes to let component temperatures cool down

2.2 Power Measurements

23. Follow startup procedure given in the MIRO Limited Functional Test

24. Record the engineering mode voltage and current from the SIS front panel.

V_{PS} = _____
I_{PS} = _____

25. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

26. Turn the calibration heater on. Record the voltage and current from the SIS front panel

Note: This step is to measure the power increase when the warm load heater is turned on. The step is not repeated in the remainder of the procedure.

V_{PS} = _____
I_{PS} = _____

27. Turn the USO on. Record the voltage and current from the SIS front panel

V_{PS} = _____
I_{PS} = _____

Note: This step is to measure the power increase when the USO is turned on and is starting to warm up. The step is not repeated in the remainder of the procedure.

28. Wait 30 minutes for the USO to warm up (should see a voltage and current drop on SIS front panel and on telemetry in EU for the 24 voltage and current readings). Record the voltage and current from the SIS front panel

Note: This step is to measure the power drop after the USO has warmed up. The step is not repeated in the remainder of the procedure so be sure that the USO has warmed up by watching for a stable current for several minutes after the warm up period.

V_{PS} = _____
I_{PS} = _____

29. Turn the calibration heater off. Record the voltage and current from the SIS front panel

V_{PS} = _____
I_{PS} = _____

30. Turn the USO off. Record the voltage and current from the SIS front panel

V_{PS} = _____
I_{PS} = _____

31. Change mode to MM Continuum

32. Record the voltage and current from the SIS front panel under two conditions:

    a) Calibrating (mirror moving)

    V_{PS} = _____
    I_{PS} = _____

    b) Not calibrating (mirror not moving)

    V_{PS} = _____
    I_{PS} = _____

33. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

34. Change mode to SMM Continuum

35. Record the voltage and current from the SIS front panel under two conditions:

    a) Calibrating (mirror moving)

    V_{PS} = _____
    I_{PS} = _____

    b) Not calibrating (mirror not moving)

V_{PS} = _____
I_{PS} = _____

36. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

37. Change mode to Dual Continuum

38. Record the voltage and current from the SIS front panel under two conditions:

    a) Calibrating (mirror moving)

    V_{PS} = _____
    I_{PS} = _____

    b) Not calibrating (mirror not moving)

    V_{PS} = _____
    I_{PS} = _____

39. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

40. Send the CTS Warmup command with heater power high (= 0) and temperature setting as indicated in the following table. Record the voltage and current from the SIS front panel.

Interface Temperature	CTS Temperature Setting
+55 ^{o} C	70 (=7)
+22 ^{o} C	40 (=4)
-20 ^{o} C	0 (=0)

V_{PS} = _____
I_{PS} = _____

41. Send the CTS Warmup command with heater power low (= 2) and temperature of 70 (= 7). Record the voltage and current from the SIS front panel.

V_{PS} = _____
I_{PS} = _____

42. Send the CTS Warmup command with heater power off (= 1). The temperature setting won't matter. Record the voltage and current from the SIS front panel.

V_{PS} = _____
I_{PS} = _____

If the temperature of the CTS is significantly greater than the interface temperature (more than +5 ^{o} C above), wait for the temperature to settle back down before continuing the test.

43. Change mode to CTS/SMM Continuum

44. Record the voltage and current from the SIS front panel under two conditions:

    c) Calibrating (mirror moving)

    V_{PS} = _____
    I_{PS} = _____

    d) Not calibrating (mirror not moving)

    V_{PS} = _____
    I_{PS} = _____

45. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

46. Send the CTS Heater Control command with heater power low (= 2) and temperature setting as indicated in the following table. Record the voltage and current from the SIS front panel and the time the command was sent.

Interface Temperature	CTS Temperature Setting
+55 ^{o} C	70 (=7)
+22 ^{o} C	40 (=4)
-20 ^{o} C	0 (=0)

V_{PS} = _____
I_{PS} = _____
Time = _____

47. Wait for the temperatures in the CTS (Telemetry channels 0 through 5) to stabilize. Record the voltage and current from the SIS front panel and the time stabilization was reached. Stabilization is reached when the current draw seen on the SIS drops and temperatures are at or near the commanded temperature.

V_{PS} = _____
I_{PS} = _____
Time = _____

48. Change mode to CTS/Dual Continuum

49. Record the voltage and current from the SIS front panel under two conditions:

    e) Calibrating (mirror moving)

    V_{PS} = _____
    I_{PS} = _____

    f) Not calibrating (mirror not moving)

    V_{PS} = _____
    I_{PS} = _____

50. Verify that all housekeeping telemetry is within appropriate limits. Print out copy of telemetry sheets. [Compare the data to the attached Mode Sheets, Appendix A].

51. Return the instrument to an OFF condition by changing mode to Engineering and powering off.

52. Wait for the component temperatures cool down to the interface temperature.

2.3 Temperature Stabilization Test

1. Follow startup procedure given in the MIRO Limited Functional Test

2. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent.

    V_{PS} = _____
    I_{PS} = _____
    Time = _____

3. Wait for interface temperatures to stabilize (≤ 5^{o} C/hour). Record the time and the interface temperatures.

    Time = _____
    Optical Bench = _____
    SBEU = _____
    EU = _____
    USO = _____

4. Change mode to MM Continuum. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent..

V_{PS} = _____
I_{PS} = _____
Time = _____

5. Wait for interface temperatures to stabilize (≤ 5° C/hour). Record the time and the interface temperatures.

Time = _____
Optical Bench = _____
SBEU = _____
EU = _____
USO = _____

6. Change mode to SMM Continuum. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent..

V_{PS} = _____
I_{PS} = _____
Time = _____

7. Wait for interface temperatures to stabilize (≤ 5° C/hour). Record the time and the interface temperatures.

Time = _____
Optical Bench = _____
SBEU = _____
EU = _____
USO = _____

8. Change mode to Dual Continuum. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent..

V_{PS} = _____
I_{PS} = _____
Time = _____

9. Wait for interface temperatures to stabilize (≤ 5° C/hour). Record the time and the interface temperatures.

Time = _____
Optical Bench = _____

SBEU = _____
EU = _____
USO = _____

10. Change mode to CTS/SMM Continuum. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent..

V_{PS} = _____
I_{PS} = _____
Time = _____

11. Wait for interface temperatures to stabilize (≤ 5^{o} C/hour). Record the time and the interface temperatures.

Time = _____
Optical Bench = _____
SBEU = _____
EU = _____
USO = _____

12. Change mode to CTS/Dual Continuum. Record the voltage and current from the SIS front panel for Engineering Mode and the time the command was sent..

V_{PS} = _____
I_{PS} = _____
Time = _____

13. Wait for interface temperatures to stabilize (≤ 5^{o} C/hour). Record the time and the interface temperatures.

Time = _____
Optical Bench = _____
SBEU = _____
EU = _____
USO = _____

3 Additional Tests During Thermal Cycling

3.1 MIRO SMM Gunn Voltage Auto-control Test

1. Set the SMM Gunn Voltage Auto-control Disable/Enable to Disable.

2. Print out copy of the telemetry sheets and record the time the command was sent in the Unit History Log.

3. As the temperature is rising, note when the PLL loses lock. Loss of lock is defined as when the SMM_PLL_ERR is outside the range a < SMM_PLL_ERR < b. When this occurs, print out copy of the telemetry sheets. Note the time on the telemetry sheet which indicates the out of lock condition and record that time with comments in the Unit History Log.

4. Set the SMM Gunn Voltage Auto-control Disable/Enable to Enable.

5. Send a change mode command to set CTS/Dual Continuum Mode to force a calibration and a reset of the Gunn Voltage.

6. Repeat steps 1 through 5 for until the transition to maximum operating temperature is completed.

7. As the Science Workstation Files close on the hour, open the just closed file and locate CTS scans near the time the out of lock condition(s) was noted in the housekeeping telemetry. Search for the first indication in the CTS science data that the Lock Alarm Bits changed from there lock state of (Bytes) 80 80 80 80 80 80. These bytes can be seen at the bottom of the graph of each CTS scan. Print out a cop of the graph. Put this graph with the appropriate telemetry sheets for that particular out of lock condition.

3.2 MIRO Asteroid Mode Test

1. Change mode to Dual Continuum.

2. Calculate the current spacecraft time in seconds. Add 900 seconds to this number.

3. Send the Asteroid Mode command with the following parameters:

   Start Time = the final number calculated in step 2 above
   Number of CTS scans = 2
   LO Starting Frequency = 0

4. Sit back and wait. The command will execute in about 15 minutes from the current time. It'll take about 8 minutes to take the data and 10 hours to get all this data out.

Appendix A, Housekeeping Values for MIRO FM Power Modes

Data Sheet 1 – Dual Continuum / Spectroscopic Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	-20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating	V	1	2.2	0	4.9
21	TLM_RF	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	2.45	2.6	2.4	2.65
23	CTS_V_Ana_2	V	2.45	2.6	2.4	2.65
24	Cold_Load1_Temp	C	-100	50	-120	60
25	Cold_Load2_Temp	C	-100	50	-120	60
26	Warm_Load1_Temp	C	-20	55	-25	60
27	OB_Temp	C	-20	35	-25	40
28	Telescope1_Temp	C	-100	50	-120	60
29	Telescope2_Temp	C	-100	50	-120	60
30	PLL_Temp	C	-20	55	-25	60
31	IFP_DET_Temp	C	-20	55	-25	60
32	IFP_AMP_Temp	C	-20	55	-25	60
33	SMM_LO_GUNN	C	-20	45	-25	65
34	MM_LO_GUNN	C	-20	35	-25	45
35	Motor_Temp	C	-20	100	-25	120

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
36	Sen_El	C	-20	55	-25	60
37	Warm_Load2_Temp	C	-20	55	-25	60
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.45	0.6	0.05	0.7
45	+12V_Curr_1_SBEU	A	0.125	0.5	0.05	0.6
46	+12V_Curr_2_SBEU	A	0.7	0.8	0.25	.085
47	-12V_Curr_SBEU	A	0.125	0.2	0.05	0.25
48	MM_GUNN_Curr	mA	150	160	145	165
49	SMM_Mult_Curr	mA	0	3	0	5
50	SMM_PLL_ERR	V	1.5	2.75	1.25	3
51	FS1_ERR	V	1	3.5	0.5	4.0
52	FS2_ERR	V	1	3.5	0.5	4.0
53	FS3_ERR	V	1	3.5	0.5	4.0
54	SMM_PLL_GUNN_Curr	mA	150	160	145	165
55	SMM_PLL_IF_PWR	V	8.2	9.3	8.0	9.5

Data Sheet 2 – Submm Cont / Spectroscopic Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	-20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating	V	1	2.2	0	4.9
21	TLM_RF	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	2.45	2.6	2.4	2.65
23	CTS_V_Ana_2	V	2.45	2.6	2.4	2.65
24	Cold_Load1_Temp	C	-100	50	-120	60
25	Cold_Load2_Temp	C	-100	50	-120	60
26	Warm_Load1_Temp	C	-20	55	-25	60
27	OB_Temp	C	-20	35	-25	40
28	Telescope1_Temp	C	-100	50	-120	60
29	Telescope2_Temp	C	-100	50	-120	60
30	PLL_Temp	C	-20	55	-25	60
31	IFP_DET_Temp	C	-20	55	-25	60
32	IFP_AMP_Temp	C	-20	55	-25	60
33	SMM_LO_GUNN	C	-20	45	-25	65
34	MM_LO_GUNN	C	-20	35	-25	45
35	Motor_Temp	C	-20	100	-25	120

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
36	Sen_El	C	-20	55	-25	60
37	Warm_Load2_Temp	C	-20	55	-25	60
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.45	0.6	0.05	0.7
45	+12V_Curr_1_SBEU	A	0.125	0.5	0.05	0.6
46	+12V_Curr_2_SBEU	A	0.7	0.8	0.25	.085
47	-12V_Curr_SBEU	A	0.125	0.2	0.05	0.25
48	MM_GUNN_Curr	mA	-*	-*	-*	-*
49	SMM_Mult_Curr	mA	0	3	0	5
50	SMM_PLL_ERR	V	1.5	2.75	1.25	3
51	FS1_ERR	V	1	3.5	0.5	4.0
52	FS2_ERR	V	1	3.5	0.5	4.0
53	FS3_ERR	V	1	3.5	0.5	4.0
54	SMM_PLL_GUNN_Curr	mA	150	160	145	165
55	SMM_PLL_IF_PWR	V	8.2	9.3	8.0	9.5

This variable does not have valid data in the defined power mode.

Data Sheet 3 – Dual Continuum Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	-20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating**	V	1	2.2	0	4.9
21	TLM_RF**	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	-*	-*	-*	-*
23	CTS_V_Ana_2	V	-*	-*	-*	-*
24	Cold_Load1_Temp	C	-100	50	-120	60
25	Cold_Load2_Temp	C	-100	50	-120	60
26	Warm_Load1_Temp	C	-20	55	-25	60
27	OB_Temp	C	-20	35	-25	40
28	Telescope1_Temp	C	-100	50	-120	60
29	Telescope2_Temp	C	-100	50	-120	60
30	PLL_Temp	C	-20	55	-25	60
31	IFP_DET_Temp	C	-20	55	-25	60
32	IFP_AMP_Temp	C	-20	55	-25	60
33	SMM_LO_GUNN	C	-20	45	-25	65
34	MM_LO_GUNN	C	-20	35	-25	45
35	Motor_Temp	C	-20	100	-25	120
36	Sen_El	C	-20	55	-25	60

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
37	Warm_Load2_Temp	C	-20	55	-25	60
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.45	0.6	0.05	0.7
45	+12V_Curr_1_SBEU	A	0.125	0.5	0.05	0.6
46	+12V_Curr_2_SBEU	A	0.7	0.8	0.25	.085
47	-12V_Curr_SBEU	A	0.125	0.2	0.05	0.25
48	MM_GUNN_Curr	mA	150	160	145	165
49	SMM_Mult_Curr	mA	0	3	0	5
50	SMM_PLL_ERR	V	-*	-*	-*	-*
51	FS1_ERR	V	-*	-*	-*	-*
52	FS2_ERR	V	-*	-*	-*	-*
53	FS3_ERR	V	-*	-*	-*	-*
54	SMM_PLL_GUNN_Curr	mA	150	160	145	165
55	SMM_PLL_IF_PWR	V	-*	-*	-*	-*

*** This variable does not have valid data in the defined power mode.**
**** These variables will only have valid data if the USO has power applied to it.**

Data Sheet 4 – Submm Continuum Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	-20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating**	V	1	2.2	0	4.9
21	TLM_RF**	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	-*	-*	-*	-*
23	CTS_V_Ana_2	V	-*	-*	-*	-*
24	Cold_Load1_Temp	C	-100	50	-120	60
25	Cold_Load2_Temp	C	-100	50	-120	60
26	Warm_Load1_Temp	C	-20	55	-25	60
27	OB_Temp	C	-20	35	-25	40
28	Telescope1_Temp	C	-100	50	-120	60
29	Telescope2_Temp	C	-100	50	-120	60
30	PLL_Temp	C	-20	55	-25	60
31	IFP_DET_Temp	C	-20	55	-25	60
32	IFP_AMP_Temp	C	-20	55	-25	60
33	SMM_LO_GUNN	C	-20	45	-25	65
34	MM_LO_GUNN	C	-20	35	-25	45
35	Motor_Temp	C	-20	100	-25	120
36	Sen_El	C	-20	55	-25	60

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
37	Warm_Load2_Temp	C	-20	55	-25	60
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.45	0.6	0.05	0.7
45	+12V_Curr_1_SBEU	A	0.125	0.5	0.05	0.6
46	+12V_Curr_2_SBEU	A	0.7	0.8	0.25	.085
47	-12V_Curr_SBEU	A	0.125	0.2	0.05	0.25
48	MM_GUNN_Curr	mA	-*	-*	-*	-*
49	SMM_Mult_Curr	mA	0	3	0	5
50	SMM_PLL_ERR	V	-*	-*	-*	-*
51	FS1_ERR	V	-*	-*	-*	-*
52	FS2_ERR	V	-*	-*	-*	-*
53	FS3_ERR	V	-*	-*	-*	-*
54	SMM_PLL_GUNN_Curr	mA	150	160	145	165
55	SMM_PLL_IF_PWR	V	-*	-*	-*	-*

*** This variable does not have valid data in the defined power mode.**
**** These variables will only have valid data if the USO has power applied to it.**

Data Sheet 5 – MM Continuum Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	-20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating**	V	1	2.2	0	4.9
21	TLM_RF**	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	-*	-*	-*	-*
23	CTS_V_Ana_2	V	-*	-*	-*	-*
24	Cold_Load1_Temp	C	-100	50	-120	60
25	Cold_Load2_Temp	C	-100	50	-120	60
26	Warm_Load1_Temp	C	-20	55	-25	60
27	OB_Temp	C	-20	35	-25	40
28	Telescope1_Temp	C	-100	50	-120	60
29	Telescope2_Temp	C	-100	50	-120	60
30	PLL_Temp	C	-20	55	-25	60
31	IFP_DET_Temp	C	-20	55	-25	60
32	IFP_AMP_Temp	C	-20	55	-25	60
33	SMM_LO_GUNN	C	-20	45	-25	65
34	MM_LO_GUNN	C	-20	35	-25	45
35	Motor_Temp	C	-20	100	-25	120
36	Sen_El	C	-20	55	-25	60

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
37	Warm_Load2_Temp	C	-20	55	-25	60
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.45	0.6	0.05	0.7
45	+12V_Curr_1_SBEU	A	0.125	0.5	0.05	0.6
46	+12V_Curr_2_SBEU	A	0.7	0.8	0.25	.085
47	-12V_Curr_SBEU	A	0.125	0.2	0.05	0.25
48	MM_GUNN_Curr	mA	150	160	145	165
49	SMM_Mult_Curr	mA	-*	-*	-*	-*
50	SMM_PLL_ERR	V	-*	-*	-*	-*
51	FS1_ERR	V	-*	-*	-*	-*
52	FS2_ERR	V	-*	-*	-*	-*
53	FS3_ERR	V	-*	-*	-*	-*
54	SMM_PLL_GUNN_Curr	mA	-*	-*	-*	-*
55	SMM_PLL_IF_PWR	V	-*	-*	-*	-*

*** This variable does not have valid data in the defined power mode.**
**** These variables will only have valid data if the USO has power applied to it.**

Data Sheet 6 – Engineering Mode Housekeeping FM Limits

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
0	Spect_T1	C	-20	70	-25	75
1	Spect_T2	C	-20	70	-25	75
2	Spect_T3	C	-20	70	-25	75
3	Spect_T4	C	-20	70	-25	75
4	Spect_T5	C	-20	65	-25	70
5	Spect_T6	C	-20	65	-25	70
6	EU_Temp	C	- 20	55	-25	60
7	ECal_Temp	DN	3295	3335	3285	3345
8	+5V_EU	V	4.7	5.3	4.5	5.5
9	+12V_EU	V	11.5	12.5	11	13
10	-12V_EU	V	-12.5	-11.5	-13	-11
11	+3.3V_EU	V	3.1	3.5	2.9	3.7
12	+24V_EU	V	23	25	22	27
13	+5V_Ana_EU	V	4.7	5.3	4.5	5.5
14	+5V_Curr_EU	A	0.1	3	0	3.3
15	+12V_Curr_EU	A	0.1	0.8	0	0.9
16	-12V_Curr_EU	A	0.01	0.11	0	0.113
17	+24V_Curr_EU	A	0.1	0.8	0	0.83
18	+3.3V_Curr_EU	A	0.1	2	0	3
19	+5V_Ana_Curr_EU	A	0.1	0.8	0	1
20	TLM_Heating**	V	1	2.2	0	4.9
21	TLM_RF**	V	1.5	4.5	0	4.9
22	CTS_V_Ana_1	V	-*	-*	-*	-*
23	CTS_V_Ana_2	V	-*	-*	-*	-*
24	Cold_Load1_Temp	C	-20	60	-40	80
25	Cold_Load2_Temp	C	-20	60	-40	80
26	Warm_Load1_Temp	C	0	75	-10	85
27	OB_Temp	C	-20	30	-30	40
28	Telescope1_Temp	C	-20	60	-40	80
29	Telescope2_Temp	C	-20	60	-40	80
30	PLL_Temp	C	-25	50	-35	60
31	IFP_DET_Temp	C	-25	50	-35	60
32	IFP_AMP_Temp	C	-25	50	-35	60
33	SMM_LO_GUNN	C	-20	45	-30	65
34	MM_LO_GUNN	C	-20	35	-30	45
35	Motor_Temp	C	-20	100	-30	150
36	Sen_El	C	-10	40	-20	50

Variable Number	Variable Name on MIRO GSE	Units	Yellow Low	Yellow High	Red Low	Red High
37	Warm_Load2_Temp	C	0	75	-10	85
38	Cal_Temp_Low	DN	440	500	430	560
39	Cal_Temp_High	DN	3700	3850	3650	3900
40	+5V_SBEU	V	4.7	5.3	4.5	5.5
41	+12V_1_SBEU	V	11	12.5	10.8	13
42	+12V_2_SBEU	V	11.5	12.5	11	13
43	-12V_SBEU	V	-12.5	-10.8	-13	-10.3
44	+5V_Curr_SBEU	A	0.1	1.4	0	1.5
45	+12V_Curr_1_SBEU	A	0.1	0.9	0	0.95
46	+12V_Curr_2_SBEU	A	0.004	0.6	0	0.8
47	-12V_Curr_SBEU	A	0.1	0.5	0	0.625
48	MM_GUNN_Curr	mA	-*	-*	-*	-*
49	SMM_Mult_Curr	mA	-*	-*	-*	-*
50	SMM_PLL_ERR	V	-*	-*	-*	-*
51	FS1_ERR	V	-*	-*	-*	-*
52	FS2_ERR	V	-*	-*	-*	-*
53	FS3_ERR	V	-*	-*	-*	-*
54	SMM_PLL_GUNN_Curr	mA	-*	-*	-*	-*
55	SMM_PLL_IF_PWR	V	-*	-*	-*	-*

*** This variable does not have valid data in the defined power mode.**
**** These variables will only have valid data if the USO has power applied to it.**